

ON THE ANATOMICAL CHARACTERISTICS OF SOME BRITISH
PISIDIA.

By NILS HJ. ODHNER.

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PLATE III.

In a previous paper ("On some species of *Pisidium* in the Swedish State Museum," Journ. of Conch., xvi, 1921, pp. 218-23) I drew attention to the anatomy of *Pisidium*, and pointed out that this gives important points for the taxonomy in that genus hitherto analysed by the systematists chiefly on conchological grounds.

The most useful characters in question are to be found in the number and structure of the gills, in the mode of fusion of the mantle margins, and in the shape of the nephridia. In the present article I give some exemplifications and illustrations of these particulars, choosing for subject two of the British species belonging to the sub-genus *Neopisidium* (with one single gill on each side and a single siphonal slit), and a third species representing *Eupisidium*. The species in question are *P. clessini*, Surbeck, *P. torquatum*, Stelfox, and *P. personatum*, Malm (cf. Odhner, loc. cit.). Some details are given of other species for comparison; but a more thorough report on those will be published at another occasion.

The British material forming the base of this investigation was kindly sent to me by Mr. Oldham; in addition, specimens from other countries have been used for completion of the details.

In the first place I will remark that the conditions described later can only be well observed under considerable magnification (about thirty to sixty times), and consequently a very sharp oblique light must be used.

PISIDIUM CLESSINI, Surbeck.

Gill.—This species (Pl. III, Figs. 1, 2) is the most simply organized of all British Pisidia. There is only one gill (or demibranch) on each side, representing the *inner* one in most of the Lamellibranchia, or the anterior one in *Eupisidium*. The gill (Pl. III, Fig. 5) consists of the direct lamella only; but a feeble trace of a reflected lamella may be considered to be present. This is, however, very incomplete, and restricted to the middle and lower parts of the gill. The uppermost filament is, just as in all Pisidia, coalesced all along the body side. The upper (about eleven) filaments have a direct course from the gill axis (*a*) towards the front, where they end without bending. Beneath this portion of the gill its filaments have reflected ends; the whole of them taken together thus forms an indistinct reflected lamella. Only the uppermost six filaments coalesce with the body surface at their ends; all the remaining ones have their ends free

from the body. A short distance behind the ends, however, the filaments are connected by an interfilamentar blood vessel (the marginal vein carrying blood from the oral sinus venosus), and this vein (*m*) is attached along the body side. From this vessel there rise small septa running backwards all along the inside of the filaments, and also towards the front end of each filament a small septum arises. The latter septa are all combined with a thin membrane, which thus covers the inside of the front part of the gill turned towards the foot. Behind the foot, in about the middle of the gill, the marginal vessel is detached from the body and joined with the corresponding one of the opposite gill (at *e*); thus, behind the foot, an interbranchial septum is formed including the blood vessel. The opposite margins of the gills (the ends of the filaments) end freely without being mutually connected. At the end of the gill the septum is attached to the mantle beneath the anal siphon, and the vein passes into the axial vessel which brings the blood into the heart.

In fertile specimens the posterior septa are highly developed by inflation and connexion into incubatory pouches. When the fry is ripe the gill is much inflated, and the reflected lamella thus becomes obsolete and looks like the immediate continuation of the convex descending one. Both gills, further, become widely separated, but hold together by means of the interbranchial septum, which thus forms the ventral wall of the single brood-pouch constituted by the two gills.

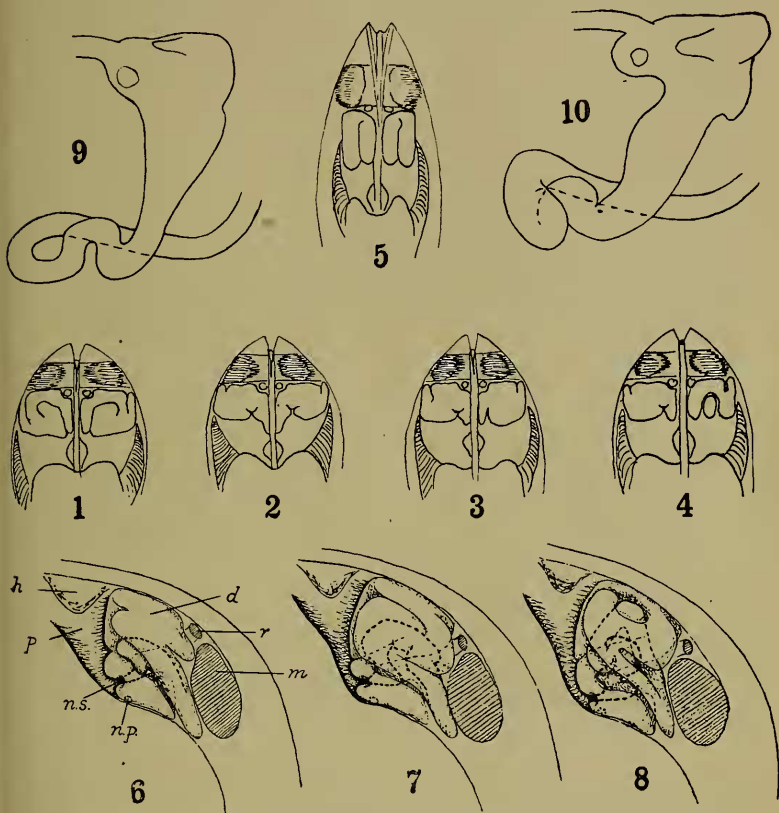
The ventral side of the gill, where the filaments bend, is wholly destitute of any marginal furrow, which in other Eulamellibranchia, as well as in all other Pisidia, marks the line of reflection of the filaments.

On the inside of the gill there are visible the interfilamentar junctions at equal distances; they are about eight in number.

The number of filaments in an adult specimen amounts to about twenty-five. In some cases a filament may be confluent with an adjacent one or may branch into two.

Mantle.—*P. clessini* shares with *P. torquatum* the peculiarity of possessing only one siphonal slit, viz. the anal one (Pl. III, Fig. 1). Here a very short siphon is formed (Pl. III, Fig. 2), the ventral portion of which is most muscular, whereas the dorsal part has lower and thinner walls. Beside this opening there exists only the long pedal slit. Behind this the mantle coalesces for a rather long space (about twice that of the siphonal opening or the height of the posterior adductor, cf. Pl. III, Fig. 1). In the mode of fusion, however, an interesting case of variation deserves to be mentioned, which I have observed in specimens from Lake of Luzern (cotypes) as well as in those from Swedish Lappland. Normally, the mantle folds which form the post-pedal suture are entirely coalesced. Occasionally, however, a fissure appears between them which may join the pedal slit so that a prolongation of it arises. In this case

the rear termination of the pedal slit proper is yet distinct; its level margins bend quite suddenly towards each other. The fissure behind it has, on the contrary, uneven margins. This fissure certainly represents a branchial slit, the development of which has been, normally, suppressed in this species.



FIGS. 1-5.—Diagrams of the nephridia in a dorsal view of *P. personatum* (1), *torquatum* (2), *clessini* (3, 4), and *amnicum* (5).

FIGS. 6-8.—Sketches of the left nephridium, seen from outside, of *P. clessini* (6), *personatum* (7), and *nitidum* (8).

FIGS. 9-10.—Stomach and intestine, seen from the left, of *P. clessini* (9) and *personatum* (10).

Nephridium.—As I have already mentioned in my paper of 1921, the nephridium of *P. clessini* shows a comparatively simple construction. Text-fig. 6 gives a sketch of the left nephridium seen from outside. The wall lining the pericardium (*p*), and that of the most proximal portion of the nephridial canal, are more strongly

outlined for the purpose of differentiation. The proximal or pericardial branch of the nephridium begins with a ciliated funnel (cf. Odhner, "Morphologische und phylogenetische Untersuchungen über die Nephridien der Lamellibranchien," Zeitschr. f. wiss. Zoologie, Bd. c, 1912, p. 330), describes a short curve towards the front and upwards, and then descends backwards; in front of the posterior adductor the canal is sharply reflected, and ascends forwards till it debouches into the wide dorsal lobe of the nephridium. That lobe, further, passes into the efferent portion, a wide canal directed medially and, distally, crossing the ciliated tube on its external side, forming here an urinary sac which debouches to the exterior by means of a pore turned towards the median line of the body (Text-fig. 6, *n.p.*).

Seen from the upper side (Text-fig. 3), the dorsal lobe has, normally, only a slight fissure in its front margin, but this character is not always constant, since exceptionally the fissure may widen to let the tip of the pericardial coil penetrate dorsally (Text-fig. 4). The figures show that an asymmetric structure of the nephridia may occur.

A comparison with the nephridium of *Calyculina lacustris* (cf. Odhner, loc. cit., 1912, p. 330, fig. 21) will reveal the fact that *P. clessini* in its nephridial characters corresponds most closely to an early embryonic stage in the development of the former genus; it is, moreover, simpler than all the species of *Eupisidium*.

Stomach.—Also from yet a fourth organic system a point of discrimination of *P. clessini* is to be obtained, viz. the intestinal canal. In all *Pisidia* the intestine crosses the lower part of the stomach (or the duodenum) on its right side. This is the case in *P. clessini*, too, but the coil formed by the intestine in front of the duodenum is somewhat longer and describes a simpler course than in other species. Further, the stomach lacks a posterior cœcum or pocket, whereas the lateral cœcum of the left side is comparatively well developed (cf. Text-fig. 9).

PISIDIUM TORQUATUM, Stelfox.

Gill.—Just as in *P. clessini* the present species (Pl. III, Fig. 3) has a single gill on each side, which, however, differs from that of *P. clessini* in shape and structure; it has a higher triangular form, it is furnished with a more or less distinct anterior marginal furrow, and it has a reflected lamella extending all along the gill, also the upper filaments thus being reflected (Pl. III, Fig. 6). The ascending lamella is narrow, occupying only about a third of the breadth of the direct one. The margin of the reflected lamella is free from the body, but a transverse marginal vessel somewhat within its edge connects the gill with the body wall, and the attachment is continued further backwards than in *P. clessini*. Behind the foot the six to eight filaments, which form the posterior lappet of the

gill, are connected to the opposite gill by means of an interbranchial septum exactly as in *P. clessini*.

After its flexure the ascending branch of the filaments is fused to the descending one for nearly the whole of its length; only the marginal end projects freely (Pl. III, Fig. 6a).

The number of filaments in the gill is about twenty-five, and the interfilamentar junctions are about eight.

Mantle.—As to the mantle, the pedal slit is very long and the post-pedal suture correspondingly short, about half the height of the posterior adductor or the length of the anal slit. I have not observed any rudimentary branchial slit like that occasionally occurring in *P. clessini*.

Nephridium.—The nephridium (Text-fig. 2) has essentially the same shape as in *P. clessini*; only it is lodged somewhat lower on the front side of the adductor.

Stomach.—The stomach has no posterior pocket but a well-developed left cœcum, and the intestine is rather short and describes a curve to the left, as in *P. personatum*, before traversing the duodenum on its right side.

Though agreeing in essential characters, the two species just mentioned differ, however, in several respects. To the anatomical differences, especially in the structure of the gill, conchological ones are added: the very feebly constructed shell of *P. clessini* contrasts greatly with the solid valves of *P. torquatum*, which are, further, equipped with the umbonal crest, a rather enigmatic phenomenon. In consideration of these facts it seems questionable whether the two species have a common origin, and it should be emphasized that the creation of a subgenus *Neopisidium* for comprising them implies only their systematic but not genetic unity. Their agreeing in simpler organization has been attained, probably, by reduction, and this process might have proceeded diphyletically. Further inquiries only can bring decision.

PISIDIUM PERSONATUM, Malm.

Gill.—I have chosen this species as a representative of the subgenus *Eupisidium* because it differs less than other species from the types described above, and thus, in some respects, serves to bridge the transition. We find here the typical two gills on each side of the body, the larger or anterior one corresponding to the single one in *P. clessini* and *torquatum*, as well as to the anterior (or inner) one in *Sphærium* and other Eulamellibranchia. This gill (Pl. III, Fig. 7) consists of a well-developed direct lamella and a smaller reflected one, which ascends to about half the breadth of the former. The margin of the reflected lamella is attached along the side of the body for more than two-thirds of its length; then, behind the foot, the margins of opposite lamellæ are united to form an interbranchial septum.

Along the margin, beneath the line of attachment, the marginal vessel runs, transporting the venous blood from the cephalic region to the filaments. This combination of the marginal vessel with the edge of the inner lamella is a characteristic met with in all Eupisidia in contradistinction to *Neopisidium*, where the vessel has been disconnected from the edge and fused to the inside of the direct lamella.

Towards this margin the filaments of the reflected lamella are free from the opposite branches in the direct lamella, but in the lower two-thirds of their length the respective branches are intimately fused (Pl. III, Fig. 7a), the reflected lamella thus becoming fused with the direct one for two-thirds of its breadth. This interlamellar fusion is a simple coalescence without any development of septa between the branches, a higher development that occurs in other species, e.g. *P. casertanum* and *henslowianum*; in the latter, further, the septa alternate in height. In the present form the connexion is extended to an equal height in adjacent filaments, though decreasing in height posteriorly.

In the rear portion of the gill the filaments are elevated on their inside, thus forming the pockets usual in fertile specimens.

There are about thirty-five filaments in the foremost gill and about eight interfilamentar junctions. The foremost crest of the gill is furnished with a distinct longitudinal furrow marking the line of reflection.

Compared with the anterior gill, the posterior one is rather small in size (Pl. III, Figs. 4, 7); it forms a narrow stripe behind the gill axis and occupies its lower half only. In other species of *Pisidium* the posterior gill generally attains a greater height. This gill is homologous with the posterior (or external) one in *Sphaerium* and other Eulamellibranchia, and consists entirely of the reflected lamella, the descending one being completely obsolete and represented only by the axial portions of the filaments. An indication of a direct lamella may be found occasionally, e.g. in *P. amnicum*.

Mantle.—On examining the mantle we find the pedal slit to be extended far backwards; the length of the post-pedal suture equals the height of the posterior adductor (and the siphonal opening), and surpasses considerably the diameter of the branchial slit. Further, it is to be mentioned that the inner mantle fold is somewhat thickened but essentially of about a uniform breadth throughout its length, this being in sharp contrast to *P. subtruncatum*, in which the pedal slit is much smaller and the post-pedal suture correspondingly very elongated; the mantle fold, further, of that species is much more swollen in its foremost portion than posteriorly.

The shape of the siphon is described and figured by Phillips and Stelfox (1918).

Nephridium.—The nephridium of *P. personatum* (Text-fig. 7) forms a step towards a higher development than that of *P. clessini*.

Its pericardial tube has become somewhat more winding, though not in such a degree by far as we find it in *P. nitidum* (Text-fig. 8). Beside this, the dorsal lobe, which completely covers the pericardial coil of the tube, is more deeply incised by a curved fissure (cf. Text-fig. 1), a feature that we meet with also in *P. casertanum*. In other species of *Eupisidium* this partition of the dorsal lobe has given rise to other aspects; thus in *P. amnicum* the fissure extends straight backwards (Text-fig. 5); in *P. nitidum* (Text-fig. 8), *P. milium*, and *P. henslowanum* it is widened to an open foramen, in which the top of the pericardial tube is visible surrounded by the narrowed annuliform dorsal coil.

The final stage in this series of the complicated tubuliform nephridium is represented by *Sphaerium* and *Caliculina* (cf. Odhner, 1912).

Stomach.—In the alimentary canal we find that the present species is furnished with a more or less distinct posterior cœcum, as well as a left one. The intestine describes, in front of the duodenum, a short coil towards the left before it turns and traverses the latter on its right side (Text-fig. 10).

EXPLANATION OF PLATE III.

FIG. 1.—*P. clessini*, Surbeck. Llyn Cwm, Clyd Nant Ffranon, Snowdon, Wales. Coll. Ch. Oldham, 17/9/1921. $\times 40$.

FIG. 2.—*P. clessini*, in adult specimen with fry in gills, showing foot and siphon protracted. $\times 40$.

FIG. 3.—*P. torquatum*, Stelfox. Grand Junction Canal, Cheddington, Buckinghamshire. Coll. Ch. Oldham, 16/7/1921. $\times 45$.

FIG. 4.—*P. personatum*, Malm. Tring, Hertfordshire. Coll. Ch. Oldham, 16/7/1921. $\times 40$.

FIG. 5.—*P. clessini*, right gill from inside. *a*, gill axis; *e*, interbranchial septum; *m*, marginal vessel.

FIG. 6.—*P. torquatum*, right gill from inside. 6*a*, Section along a filament showing the marginal vessel (*m*), septa (*s*), and free edge of reflected lamella (*l*).

FIG. 7.—*P. personatum*, right gills from inside. 7*a*, Section along a filament showing the coalescence of its branches.